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# Memory Efficient Surface Reconstruction Technique

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***Abstract— Surface reconstruction is the process to achieve three-dimensional complex surface model basically the algorithm used are start algoritm and filtering algoritm to remove the redundancy factor. The proposed system reduces the size in bytes and bad poles to obtain the accurate and efficient output. The base algorithm is applied to obtain a CAD-model from the given ICADM using power crust. The concept therefore can be inductively extended to an arbitrary number of surface reconstruction algorithms having right properties.***

***Keywords— accurate,efficient, reconstruction, properties,arbitrary***

## I. INTRODUCTION

### 1.1 SURFACE RECONSTRUCTION

Surface reconstruction [4] is the process to achieve three-dimensional complex surface model quickly and accurately from three-dimensional data obtained as a sample, which is widely used in reverse engineering. Three-dimensional data collected by measuring device is usually large, therefore it is known as Point Cloud data. Point cloud data can be considered as an aggregation of the points in three-dimensional space, and each point cloud data has coordinates x, y, z as its axis . According to the different forms of data, point cloud data can be distinguish into two forms:

I. Ordered point cloud
II. Scattered point cloud.

Reconstruction of ordered point cloud is constructing the surface of points sample from the verge of object to approximate the original surface mainly. Although, due to the limitation of gathering devices or the different collecting ways, there is no such type of the points, hence the points are known as scattered point cloud. For the scattered point cloud, if the reconstructed surface displays the shape of the original point cloud, it is known as the result of the surface reconstruction.

Surface reconstruction is challenging as the topology of the real surface is not known the acquired data can be non-uniform and contaminated with the noise and reconstructing surfaces from data sets can be prohibitively expensive in the terms of computations and memory usage. A lack of information of the surface orientation at the acquired samples may arise the problem[1].

The problem of creating a CAD model for an existing physical object from a given set of points of the object surface is important in many fields of science and industry. There are many methods available for the solution of this problem. These methods are based on different types of principles and have different properties, which in many cases allow choosing the most suitable algorithm to be implemented for a given task. At the same time many people donot bother about two problems which often arises. The first one is that we often deal with very large clouds points like clouds representing buildings. Processing such clouds of points often leads to the problem lack in machine resources even for the modern powerful computers. Although this problem is a particular case of minimization of the cost of surface reconstruction. The second problem can be arises as -What to do, if an algorithm is not able to reconstruct a CAD model completely? This problem arises mainly when the clouds of points are obtained outside the laboratory. The problems are found both: separately as well as together[2]. The aim of surface reconstruction is to obtain a digital representation of a real, physical object or phenomenon described with a clouds of point, sampled on its nearby surface. There is a novel technique for surface reconstruction, which employs regularized-membrane potentials, evaluated on a volumetric grid, to obtain smooth surfaces from noisy and sparse data as output. The aim of these potentials is to aggregate data points and to remove outliers due to noise. It is denoted by aggregation the process in which gaps between the data points are bridged by a slowly varying scalar field. The purpose of surface reconstruction is to obtain a digital representation of a real, physical object or phenomenon described by a cloud of points, which are sampled on or near the object's surface. The growing interest is due to the increasing availability of point-cloud data, which may be obtained from medical scanners, laser scanners, vision techniques etc. In computer vision, shape recovery is a classical problem, whose aim is to derive a 3-D scene description like surface normal and surface depth from more 2-D images. All techniques that recover shape are called shape-from-X, where X can be shading, stereo, texture, or silhouettes, etc.[5]. Like, in the stereo problem one first extracts features like corners, lines, etc. from a collection of images, and then solves the correspondence problem i.e. matching features across images. After obtaining depth information at the locations of the extracted features, one needs to reconstruct the surfaces of the objects present in the scene. One way of achieving this is by using techniques that reconstruct surfaces from point clouds.

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Reconstructing a surface from an unordered data set has been a significant yet challenging problem in computer graphics . As a step of creating computer graphics surface reconstruction fills the gap between machine perception and machine understanding i.e. it process the scanned data into a continuous model. Due to the development of 3D scanners and the demand of computer graphics the research has been done in the surface reconstruction field much of which is dedicated to the watertight surface reconstruction for its topological simplicity and desirable properties. Open surface reconstruction problems occur often in real applications, such as incomplete scanned data. As it has been seen, the open surface reconstruction problem to some extent, has more significance than the watertight surface problem for its topological generality. The definitions of watertight and open surface are :A surface is defined as 2-manifold embedded in R3. Here it restrict a surface to be a compact 2-manifold which refers to watertight surface. An open surface is defined as a 2-manifold with boundary embedded in R3. The boundary of a manifold S is represented by @S [3]. Most surface reconstruction methods can be differentiated into two groups- explicit methods and implicit methods. Explicit methods are mainly local geometric approaches based on Delaunay triangulation and dual Voronoi diagram such as Alpha
shape and CRUST algorithm . The advantage of these methods is their theoretical guarantee that there exists a sub complex of Delaunay triangulation of the data set which is homeomorphic to the surface. Since these methods are local approaches the global topological characteristics such as watertight or open will not affect their performances. Their aim is the potential homeomorphic subcomplex embedded in the Delaunay triangulation. The topology of the sub complex surfaces does not make any difference. Therefore the explicit method can handle a number of open surface cases. However, the explicit methods are subject to many reconstruction difficulties such as non uniformity, undersampling, and noises . Hence the variational models were brought into the reconstruction field. The reconstruction problem is formulated as a minimization problem in a energy functional defined over surfaces. To minimize the energy with respect to the surface, a parametrization of the surface is not always available during the optimization procedure. An important level set approach based on solving the underlying partial differential equations was proposed by Zhao in . As an alternative, graph cuts can also minimize the energy functionals over implicitly defined surfaces and has been applied to the surface reconstruction problem. The advantage of graph cuts is its efficiency and ability to find global minima. However, both the level set method and graph cuts is lost in general topologies .There are some reconstruction methods to handle open surfaces recently which work successfully in practice. Although the robustness or the efficiency is still in study all these methods for open surfaces have some disadvantages and it is not clear how to devise these methods for curves and surfaces that have ends or edges within the computational domain[3] .

## II. RELATED WORK

The various approaches used for the surface reconstruction are described below:

### Efficient Surface Reconstruction using Generalized Coulomb Potentials

This process is provided by Andrei C. Jalba[1] in 2007 proposed geometrically adaptive method for surface reconstruction from noisy and sparse point clouds without orientation information. It method involves a fast convection algorithm to attract the evolving surface towards the data points. The force of field in which the surface is convected is based on generalized Coulomb potentials evaluated on an adaptive grid using a fast hierarchical algorithm. The formulating reconstruction as a convection problem in a velocity field generated by Coulomb potentials offers a large number of advantages. The methods that compute the distance from the data set to the implicit surface which are sensitive to noise due to the distance transform our method is highly resilient to shot noise since global generalized Coulomb potentials can be used to disregard the presence of outliers due to noise. The Coulomb potentials represent long range interactions that take all data point and they convey global information which is crucial in the fitting process. Both the spatial and temporal complexities of our spatially adaptive method are proportional in the size of the reconstructed object that makes our method compare favorably with respect to previous approaches in terms of speed and flexibility.

### Enhanced Surface Reconstruction Algorithm

The author Abhishek Bansal[2] in 2012 proposed the aim of surface reconstruction is to find a surface from a given finite set of geometric sample values. In atmost applications the sample values are points. But different types of samples like curves occurring like in tactile sampling adapting milling machine or volume densities occurring for instance in X-ray based computer tomography are possible. Reverse engineering of geometric shapes is the process of converting a large number of measured data points into a concise computer representation. As it is the inverse of the traditional CAD and CAM procedures that create physical objects from CAD models. Triangulating scattered point sets is a important problem of reverse engineering. The given set of unorganized points which lie on the boundary surface of a three-dimensional object, and without the information on the topology so our aim is to reconstruct the surface by building a triangular mesh using the given points as vertices. The resulting polyhedron could also be the input of procedures like surface fitting, or can be visualized with different textures.

### Reconstructing Open Surfaces via Graph-Cuts and its algorithms

The author Min Wan, Yu Wang, Egil Bae, Xue-Cheng Tai, and Desheng Wang[3] in 2013 presented an orientation inference framework for reconstructing implicit surfaces from unoriented point clouds. The novel graph cuts based method is proposed for reconstructing open surfaces from unordered point sets. Through a Boolean operator on the crust around the data set the open surface problem is translated to a watertight surface problem within a restricted region. Integrating the model Delaunay-based tetrahedral mesh and multiphase technique the proposed method can reconstruct open surfaces effectively. A surface reconstruction method with domain decomposition is presented which is based for the new open surface reconstruction method. The method can handle more general surfaces such as non orientable surfaces. Therefore algorithm is designed in a parallel friendly way and measures are taken to remove cracks and conflicts between the subdomains.

**Surface Reconstruction Using Scattered Cloud Points**

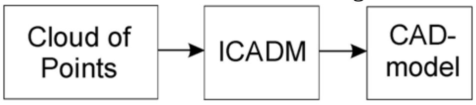
The author Shivali Goel[4] in 2013 define surface reconstruction as means that retrieve the data by scanning an object using a device such as laser scanner and construct it using the computer to gain back the soft copy of data on that particular object. Surface reconstruction is a reverse method. It is mostly useful when in a particular object original data is missing without doing any backup. Hence by doing like this the data can be recollected and can be stored for future purposes. To develop a system for image reconstruction from scattered cloud points. The crust algorithm with umbrella Filtering can be implemented and compared for time taken by the algorithm in surface reconstruction. The main goal of the algorithm is to filter out left insignificant data while preserving an acceptable level of output quality.

**Surface Reconstruction Using Regularized Membrane Potentials**

The author Madhura A. Patil[5] in 2014 presents a physically motivated method for surface reconstruction that can recover smooth surfaces from noisy and sparse data sets without using orientation information. A new volumetric technique is based on regularized membrane potentials for aggregating the input sample points introduced which manages improved noise tolerability and outlier removal without sacrificing much to the detail recovery. The sample points are first aggregated on a volumetric grid. The labelling algorithm that relies on intrinsic properties of the smooth scalar field emerging after the aggregation is used to classify grid points as exterior and interior to the surface.

## III. PROPOSED METHODOLOGY

The start algorithm is applied first for processing an input as cloud of points. An filtering algorithm is applied so that wrong edges, triangles and bad poles can be removed(to obtain an ICADM using crust). And an algorithm basically base algorithm is applied to obtain a CAD-model from the given ICADM using power crust. The concept therefore can be inductively extended to an arbitrary number of surface reconstruction algorithms having right properties.



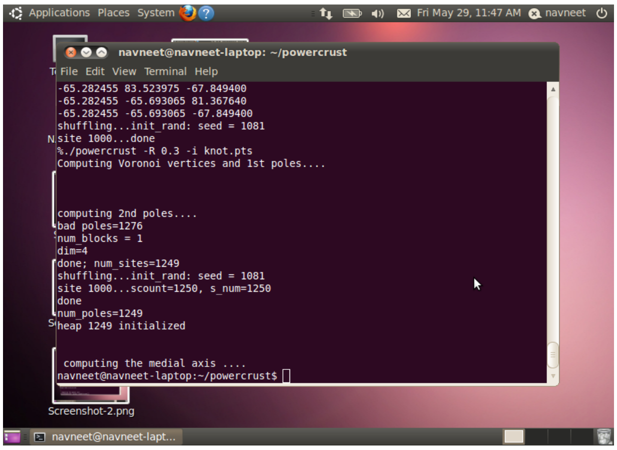




Figure3.1: shows the number of bad poles removed so that redundancy can be removed to increase the efficiency of the output.

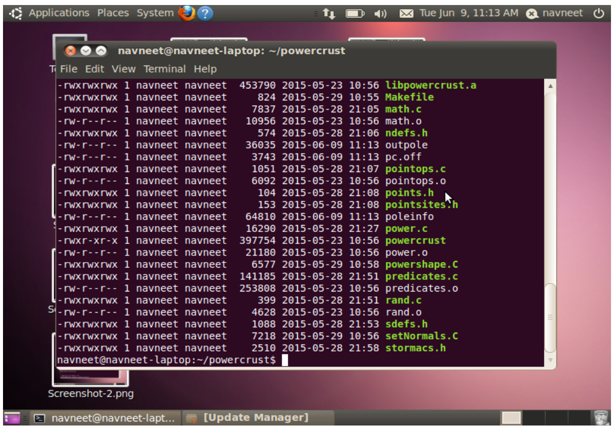



Figure 3.2 : shows the pc off file that shows the sizes in bytes .

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## IV. RESULTS AND DISCUSSION

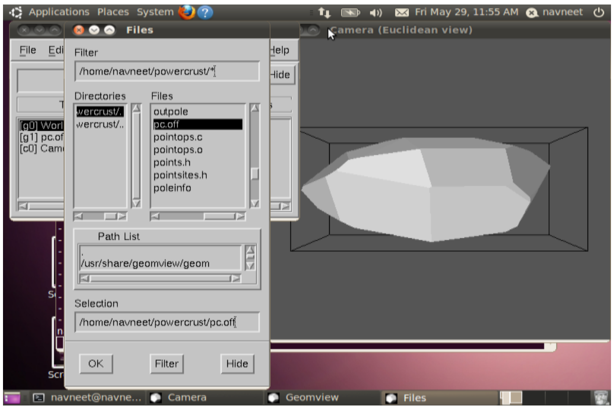


Figure 4.1 : shows the result obtained by removing the bad poles and size in bytes.

Table 4.2 : shows the relationship between R and Size in bytes and R and Bad poles.

| **Redundancy factor** | **Size in bytes** | | **Redundancy factor** | **Bad Poles** |
|---|---|---|---|---|
| | 390287 | | | 0 |
| 0.1 | 10 | | 0.1 | 1277 |
| 0.5 | 279769 | | 0.5 | 909 |
| 0.2 | 10 | | 0.2 | 1277 |
| 0.3 | 3743 | | 0.3 | 1276 |
| 0.4 | 153784 | | 0.4 | 1183 |

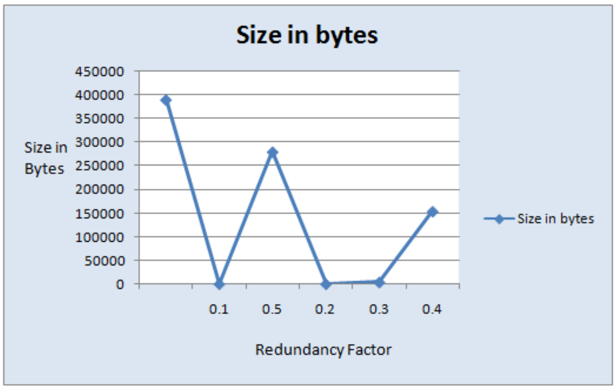


Figure 4.3: shows graph between R and size in bytes

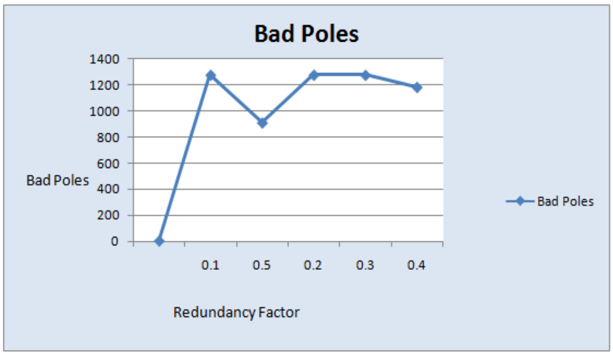


Figure 4.4: shows graph between R and bad pole

## V. CONCLUSION

From the above discussion it can be concluded that the bad poles are removed to save the space and also to remove redundancy. By doing the enhancement using filtering algorithm the size in bytes is reduced to obtain the correct and efficient output. The developed algorithm is able to create 3-D meshes with variated geometry, in a multiresolution fashion. Some heuristics used allow a selective refinement, from coarser resolutions to finer resolutions, according to a threshold value based on minimum distance from the mesh triangles to the training set.

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